Acoustic Behavior, Baseline Ecology and Habitat Use of Pelagic Odontocete Species of Concern

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LONG-TERM GOALS

Obtain critical sound use, behavioral ecology, and fine-scale habitat information of two pelagic species of odontocete cetaceans which inhabit regions of significant U.S. Naval operations and may be impacted by coincident Naval training activities. The goal is to establish baseline acoustics, behavior and ecology of these species to predict and mitigate potential human impacts. Information gained will provide a context for evaluating natural behavioral ecology and potential responses to anthropogenic sounds.

OBJECTIVES

Through detailed, non-invasive, bioacoustic behavior measurements:

1) Quantitatively assess the acoustic signals of Hawaiian insular false killer whales (FKWs) and melon-headed whales (MHWs).

2) Determine baseline acoustic behavior, diel activities, detailed dive patterns and fine-scale habitat use for both species.

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3) Pair data on the acoustic characteristics of calls with behavioral ecology information to evaluate the potential for species classification, passive acoustic detection, and density estimates.

APPROACH

Data will be collected with non-invasive, suction cup tags (DTAG3) attached to individual Hawaiian insular false killer and melon-headed whales. This project will be conducted over four, 2-week tagging periods spread between three years. The DTAG is a miniature sound, orientation, acceleration and depth recording tag (Johnson and Tyack 2003; Johnson et al. 2009). It can reveal whistle communication and echolocation (during foraging/orientation) as well as the animal's 3-dimensional behavior such at pitch, roll, orientation, and dive profile. The tag's hydrophones record received levels and relative direction of external sound sources such as vessel noise or conspecifics. This tag has been widely used to measure the acoustics and behavior of cetaceans (Johnson et al. 2004; Tyack et al. 2006; Stimpert et al. 2007).

Two of the four tagging operations will be conducted on the leeward (southwest) side of island of Hawaii, and the other two operations would be either off one or both of the leeward sides of Oahu or Lanai/Maui. We plan to focus on Hawaii Island as satellite and time-depth tags have been successfully deployed there on both FKWs and MHWs. The north end of the island is a high use area for Hawaiian insular false killer whales (Baird et al. upublished), and there is a resident population of melon-headed whales off the north end of the island (Aschettino et al. 2011). Combined with a substantial lee this is probably the best area for tagging and tag retrieval within the main Hawaiian Islands. However, both species have been routinely sighted off Lanai and Oahu and efforts distributed across several islands will maximize tagging success as well as overlap with regions of significant U.S. Naval interests. The Hawaii Island tag and tag retrieval will be conducted using Cascadia Research Collective vessels (typically used for FKW and MHW satellite tagging).

Once a group is sighted, the boat will gradually approach to allow whales to acclimate to the vessel. Both FKWs and MHWs are easily approachable, typically showing no avoidance behavior and often regularly approach small vessels to bowride. Individuals will be photo-identified to determine patterns of individual, group, and population affiliation (Baird et al. 2008) and for later comparison to ensure no lasting effects of the suction-cup tags. Ancillary data including group size, location and accompanying species of birds, fish and marine mammals will also be recorded. Groups will then be approached to a shorter range (5 m) for tagging. Based on experience from satellite tagging and biopsy efforts, as well as DTAG-ing of other odontocetes, both FKWs and MHWs are expected to ride the bow-wake or swim adjacent to the vessel for long enough periods of time to enable tagging. When the whale surfaces to breathe it exposes its back and dorsal fin, during which time the long, carbon fiber pole with tag attached will be lowered and the suction-cup tag will be attached to the whale's back (between the blowhole and dorsal fin). Tag attachment will be digitally recorded by video and still camera to document any behavioral reactions. The vessel paths and tag deployment positions will be noted via GPS coordinates (via tag and boat). Goal tag durations will be 2-8 hrs depending on the time of day the group is encountered. Because both species are highly mobile, contact will be maintained with the radio-beaconed tag by following with the tagging boat at a range of ~1 km. Tags are intended to be recovered using the same vessel. However, should severe weather prevent staying near the tagged animal by boat, the land-based tracking will be maintained and alternate vessels will be coordinated.

Tagging will be conducted and leveraged with ongoing satellite tagging operations of false killer whales and other species being funded to Cascadia Research Collective. This has the advantage of dissipating tagging operations costs and increasing available field time. Further, previously attached satellite tags, which hold for long durations (up to several months), will provide the locations of animal groups, thus improving our abilities to find and DTAG animals. MHWs are much more abundant, with one population resident off Hawaii Island (Aschettino et al. 2011); thus the encounter success for these animals is expected to be relatively high.

Analysis: One of the primary advantages of the DTAG is it pairs fine-scale dive and swimming measurements with acoustic behavior. Dive and movement analyses will include: dive rates, dive angles, accelerations, swimming speeds, diurnal activity and associations with other individuals. Acoustic analyses that will be addressed will include click rates and click types. We will seed to examine echolocation click characteristics (e.g. peak frequency, bandwidths, centroid frequency). The specific analyses will be either from the tagged animal, or if possible, from its conspecifics. Some analyses are dependent on orientation of conspecific sound-emitters to the tag and may yield 'apparent' such information as 'apparent' click characteristics (Madsen et al. 2004). We will also seek to quantify whistle characteristics, whistle rates, and potentially whistle types and estimated source levels. The acoustic data will initially be assessed to evaluate the descriptive parameters such as maximum, minimum, mean, median and range for the click data noted above. These will be compared between FKW and MHW as well as to published literature on other species to determine whether the animals investigated here may have species-specific click parameters. Classifying these clicks may be dependent upon click types, such as buzzes vs. search clicks. Following Sayigh et al (2009) we will initiate similar investigations of species specific whistle classifications. Characteristics initially assessed to yield species-specificity include the peak frequency, interclick interval (as suggested in some beaked whales) and whistle frequency contours (Oswald et al. 2003; Oswald et al. 2004). Sound types will then be compared to dive movement and behavior, examining prevalence of sounds in various parts of the dive as well as vocalization rates. This information, along with the acoustic definitions, is expected to provide early indications of how acoustic classification and detection methods will proceed for these species. All data will finally be compared with non-tag data of habitat (depth, bottom contours, surface seawater temperature, bird presence), group composition, and behavioral state.

Data will initially be reviewed in the field to insure accurate recordings but primary analysis will occur in concert at the Marine Mammal Behavior (Tyack) and Sensory Ecology (Mooney) Labs at WHOI. We will coordinate the acoustic analyses with the Marine Mammal Research Program (Nachtigall-U. Hawaii) and graduate student Aliza Milette. A portion of the analyses will contribute to Ms Milette's graduate education. Analyses will primarily be conducted using Adobe Audition and MatLab custom scripts.

WORK COMPLETED

The first research field effort is scheduled from Oct 18-Nov 15, 2011. This effort will be undertaken simultaneously with a NOPP/ONR funded project to Alaska SeaLife Center and Cascadia Research to increase the field time available for tagging. Because this was the first false killer whale/melon-headed whale DTAG field effort, it has required extensive planning and preparation. Baird applied for and received a new permit for scientific research and tagging of marine mammals from the National Marine Fisheries Service (NMFS) Office of Protected Resources. Mooney and UH graduate student Aliza Milette have been addressing the DTAG preparations and analyses. This included initiating a

protocol for tagging operations. Baird and Mooney have met to plan field dates, time and organization. Baird and Mooney have also met separately with NMFS researchers to describe and inform them of the research plans.

RESULTS

Tagging operations will begin Oct 18, 2011 and preliminary analyses will be addressed immediately. Expected preliminary results include:

(a) Successful tag deployments and retrieval of tags on both species.

(b) Dive profiles

(c) Recordings of sound production

(d) Fine-scale movement data, including tagged animal's pitch, roll, and acceleration

The acoustics and fine-scale movement data will be novel results. Pairing these with dive profiles will be particularly powerful assessments of acoustic behavioral ecology. These formal analyses will occur after the cruise.

IMPACT/APPLICATIONS

This research will provide necessary baseline sound-use and dive behavior data on two cetacean species of concern which occupy waters frequently used in U.S. Naval training operations. This work will improve our understanding of the acoustics, dive behavior and habitat use of two odontocetes species with significant anthropogenic interactions: the insular Hawaiian false killer whale, a species-of-concern, petitioned to be listed as an endangered species, and the melon-headed whale, a species recently involved in a near mass-stranding event following naval activities. Few acoustic or behavioral data exits for either species in the wild. These results will provide vital baseline information on the vocalization characteristics and use of sound by both species. These data as well as dive related acoustic behavior and habitat use will provide novel biological information for pelagic odontocetes with implications for monitoring and acoustic detection. Data collected will provide a context for studying behavioral responses to anthropogenic influences such as sonar sounds. Information can be applied to future acoustic detection models, predicting areas of cetacean occurrence, means of mitigating potential sonar-induced impacts, supporting encounter avoidance and assessing future effects.

RELATED PROJECTS

ONR: Tagging and Playback Studies to Toothed Whales; Award Number: N00014-09-1-0528

ONR: Improving attachments of remotely-deployed dorsal fin-mounted tags: tissue structure, hydrodynamics, in situ performance, and tagged animal follow up; Award Number: N00014-10-1-00686 (sub-award to Cascadia Research Collective). Field efforts in October/November 2011 will be combined with field efforts under this project to leverage additional field time for tagging.

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